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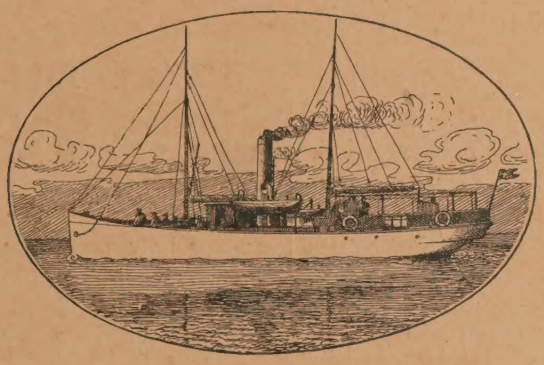

XXXII.

1926.

By

C. G. Joh. Petersen,
Ph. D., L. L. D., D. Sc.
Director.

Copenhagen.
In Commission by G. E. C. Gad.
Centraltrykkeriet (C. Ferslew).
1927.

C. G. Joh. Petersen: Om de skalbærende Molluskers Udbredningsforhold i de danske Have indenfor Skagen 1888. 8°. 162 pg. 2 Kort.

Det videnskabelige Udbytte af Kanonbaaden »Hauch«s Togter i de danske Have indenfor Skagen. 1893. 4°. 464 pg. Atlas i folio.

Indhold: Echinodermata (Petersen), Diatomeer (Cleve), Undersøgelse af nogle Bundprøver (Rørdam), Mollusca (Petersen), Cephalopoda (Posselt), Crustacea malacostraca (Meinert), Hydrografi (Rørdam), Polyzoa (Levinsen), Ascidiæ simplices (Traustetd), Annulata, Hydroidæ, Anthozoa, Porifera (Levinsen), Nogle alm. Resultater (General Results, Engl.) (Petersen).

C. F. Drechsel: Oversigt over vore Saltvandsfiskerier med Kort og Planer. 1890. 4° 100 pg. Med et Tillæg: »Om Naturforholdene indenfor Skagen« af *C. G. Joh. Petersen.* Med Kort. 4°. 46 pg.

Fiskeri-Beretning for $18^{88}/_{89}$ til 1916.

Beretninger fra den danske biologiske Station findes paa dansk publiceret i de tilsvarende Fiskeri-Beretninger, til Beretning XXI med Tillæg. Senere udgives de som selvstændige Publicationer paa Dansk og paa Engelsk.

The Reports from The Danish Biological Station are also published in Danish in the corresponding Fiskeri-Beretning, until Report XXI with Appendix. Later on they are specially published in Danish and in English, but not in the Fiskeri-Beretning.

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II. Om vore Kutlingers *(Gobius)* Æg og Ynglemaade. (1891—92.) 9 pg. Med 2 Tavler.
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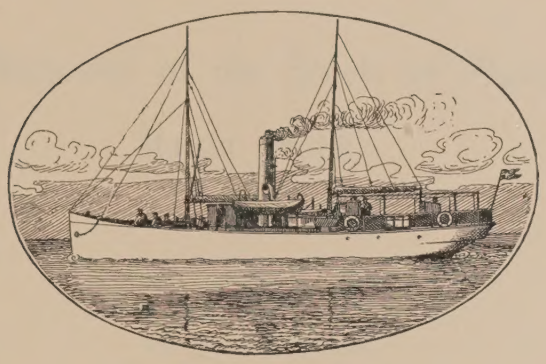

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On the Renewal of the Stock of Plaice in the Baltic proper.

By

H. BLEGVAD.

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I. Previous Investigations.

During many years the question, how the renewal of the stock of plaice may be imagined to take place in the Baltic proper*), has been the object of animated discussion among fishery biologists. While these have always agreed that the renewal of the stock of plaice in the North Sea and the Kattegat takes place by the appearance of young plaice on the shallow and sandy coasts of these waters, many different theories have been formulated from time to time to explain the fact that the various attempts to find any quantity of the year's brood (the 0-Group) on the coasts of the Baltic proper have failed again and again. The Baltic which, especially in respect to hydrography, differs in its relatively low salinity from our other waters, might very well be imagined to present especially difficult conditions for the thrival of the young of the plaice.

C. G. Joh. Petersen, the Director of the Danish Biological Station, was the first to raise the problem. In Report IV from the Dan. Biol. St. (»On the Biology of our Flat Fishes«), 1894, he says that in spite of search on suitable places both in shallow and deep water in the Baltic only 4 plaice in all were found (3 at Bornholm in September and 1 at Hesnæs in August, all of them in shallow water at the shore) which were so small that they possibly might belong to the 0-Group; it must be borne in mind that determinations of age by means of the otoliths were unknown at that time, as this metod was not brought into common use until after the commencement of the new century. Dr. Petersen as a result of his investigations has stated that the bottom stages of the 0-Group of the plaice were to be found in great numbers along the coasts of the Kattegat and the Belt Sea at the same time as they were practically missing in the Baltic proper, where the population of adult fish all the same was very dense; he is of opinion, therefore, that an immigration of plaice must be imagined to take place from the Kattegat or the Belt Sea to the Baltic. He presumes that this

*) With the Baltic proper I understand that part of the Baltic which lies East of the line Gedser—Darsserort.

immigration takes place while the plaice are still quite young, about 1—2 years old. He emphasizes, however, the possibility that in certain years greater amounts of the 0-Group may be found than in other; in a note page V he adds that catches have subsequently been taken of pelagic fish eggs, probably of turbot and plaice, in the deep saline water-layers in the Baltic, and of some more young plaice below 2 inches in length; "it is thus probable" he writes, "that turbot and plaice, exceptionally, may be developed from eggs in this saline water in years when such water is found at Bornholm".

In Report V from the Dan. Biol. St. (1896) Dr. Th. Mortensen ("Continued Researches on the Occurrence of the Fry of Plaice in the Baltic Sea, in 1894 and 1895") gives information of the recent catches of young plaice in the Baltic. In July-August 1894, 34 young plaice were found, measuring 3—6½ cm in length; of these 1 was caught in the Bay of Faxe, the rest at Bornholm, and all of them in quite shallow water near the shore. Of these plaice the author however only numbers among the 0-Group, the 26 specimens taken by Lieutenant Jessen from the „Hauch" at Bornholm; the rest he classes as I-Group. Furthermore in July 1895 9 plaice of a length of 2½—6½ cm were taken; 2 of them were caught on the coast of Bornholm, the rest in Faxe Bay; but the author only numbers one of the plaice from Bornholm among the 0-Group, the rest among the I-Group. I shall later on return to these determinations which possibly are incorrect; so the possibility is not excluded that all the plaice mentioned above may belong to the 0-Group. Dr. Mortensen does not think that the fish eggs found are plaice eggs, but cod eggs, and that only very few eggs are turbot eggs. He therefore, basing his conclusions upon the material at hand, dares not express himself about the question whether the plaice in the Baltic generally immigrates from other places or not. "The facts at hand perhaps go to show that plaice in some quantity only in certain years are developed in the Baltic, the stock of plaice of the Baltic thus being probably for the most part recruited by immigration from the Kattegat. Further investigations are necessary to settle this interesting problem. Till the quite young ones below ½—1 inch (and best, too, the eggs) have been found there, we are unable to know for certain whether the plaice on the whole does propagate in these waters." In Mitt. d. Deutschen Seefischerei-Vereins Bd. XIII, 1897 ("Sind die Ostsee Schollen vom Kattegat her eingewandert?") Dr. Mortensen expresses himself in the same direction; yet he finds it improbable that the young plaice which sometimes — but not every year — are to be found at Bornholm, should originate from the Kattegat. But "as long as we have not with certainty found both the eggs and the various stages of development of the young there (i. e. in the Baltic proper) we must confess that it has not been proved that their whole development takes place there. In any case it is sure that the few young plaice which are to be found at the coasts of the Baltic, cannot alone recruit the numerous stock of plaice of the Baltic. The main part, at least, must have immi-

grated." As it will be seen, Dr. Mortensen more particularly follows the immigration hypothesis while he on the other hand clearly emphasizes the possibility that a considerable amount of young plaice in certain years may be developed in the Baltic proper.

From the German side the immigration hypothesis was supported by C. Apstein ("Junge Schollen kommen nicht in der Ostsee vor?" Mitt. d. Sektion f. Küsten und Hochseefischerei (1894) Bd. X); his search for young plaice at Eckernförde in 1893 gave no result. Likewise, G. Duncker ("Die Frage nach einem indigenen Schollenbestand der Ostsee" and "Noch einmal die Ostseescholle" in Mitt. d. Deutschen Seefischerei-Vereins Bd. XIII, 1897) found only very few young plaice in the Neustädter Bay. Also Schiemenz (Abhandlungen d. Deutschen Seefischerei-Vereins Bd. VII, 1902) is of the same opinion as Dr. Petersen, since during the "Holsatia" expedition in the Baltic in 1901 only one single plaice of the 0-Group was found in a material of many hundreds; it was captured in comparatively deep water, viz. in a depth of 28 metres on the Adler Bank. From the Swedish side Trybom in "Svenska hydrografisk-biologiska Kommissionens Skrifter, I, 1903", reported that spawning plaice, both males and females, were found in 1901 at Bornholm. In "Svensk Fiskeri-Tidsskrift XII, 1903, he furthermore was able to communicate that he in November 1902 had found some few pelagic plaice eggs in the salt bottom water in the Bornholms Deep; as it will be remembered, such pelagic plaice eggs had not yet been ascertained with certainty in the Baltic proper.

In 1904 Ehrenbaum and Strodtmann in Wissensch. Meeresunters. N. F. VI Bd., 1904, made the whole matter the object for a thorough discussion. In February 1903 they found pelagic plaice eggs distributed over vast areas of the Baltic and in some places very numerous, even far eastward in the Baltic. Also some few pelagic plaice larvae were caught in the Baltic proper, and in the western Baltic they occurred in numbers. Furthermore the authors mention that in August—September 1903 they found hundreds of plaice of the 0-Group in the western Baltic (at Eckernförde and Lübeck). They therefore think themselves entitled to declare that "the plaice carries through its whole development in the Baltic; an immigration from other waters is not necessary to secure the stock". All the same, the views of the authors are very nearly the same as Petersen's and Mortensen's. Ehrenbaum and Strodtmann, after having stated that the last named authors by "the Baltic" only understand the Baltic proper, write as follows: "Wir müssen zugestehen, dasz unsere bisherigen Untersuchungen nicht genügen, die Petersensche Einwanderungshypothese für diesen Teil der Ostsee (viz. the Baltic proper) zu widerlegen. Wir haben allerdings festgestellt, dasz Scholleneier hier in entwicklungsfähigem Zustande abgelegt werden, auch einzelne Larven haben wir konstatiert, von Petersen selbst und Mortensen sind die ersten Bodenstadien bei Bornholm gefunden, so dasz wir mit groszer Sicherheit behaupten können, dasz die Scholle ihre ganze Entwicklung auch in der öst-

lichen Ostsee durchmachen kann. Aber ob die Fortpflanzung so regelmäszig und so intensiv stattfindet, dasz der ganze Bestand davon herstammen kann, entzieht sich unserer Beurteilung". They therefore also must suppose an immigration on a large scale for this part of the Baltic, and they emphasize that the most essential difference between their own view and that of Dr. Petersen is only that they do not look upon the Kattegat as the birthplace*) of the eastern plaice, but the western Baltic together with the southern Kattegat, which waters they consider as one sea-territory from which a fluctuation of the plaice stock takes place, also into the eastern part of the Baltic. In the year 1903 they think that the western Baltic has been the centre of the spawning of the plaice.

C. Apstein ("Junge Butt in der Ostsee". Wiss. Meeresunters. N. F. Bd. VI, 1904) having reported on the occurrence of plaice of the 0-Group in the Eckernförde Fjord during the years 1895—99, and A. Krüger ("Über die Verbreitung junger Schollen an der deutschen Ostseeküste 1903". Mitt. d. deutschen Seefischerei-Vereins Nr. 12, 1903) having communicated the catches of plaice young in the year 1903 at Kiel, Travemünde and Warnemünde (whereas he got no at Rügen), Dr. Petersen in Rep. XII from the Dan. Biol. St., 1905, renders an account of the recent Danish investigations. In this work he shows that the southern and eastern limits for the occurrence of the young plaice at the Danish coasts are subject to considerable displacements year by year. Thus the limit in 1902 was found to be so far eastward as between Darsserort and the south end of Lolland, whereas it in 1893 was found at Fænø in the Lesser Belt and at the north end of Langeland in the Great Belt. Dr. Petersen thinks that the conditions were about the same in 1900 as in 1893, whereas 1903 has been more like 1902 with respect to the extension of the plaice's 0-Group. It is expressly mentioned, that in 1901 and 1903 it was impossible to find any individual of the 0-Group at Bornholm, in spite of eager searching. The thorough investigation of the Danish coasts which in 1902 was carried out by Johs. Schmidt, then the assistant of Dr. Petersen, showed that while there were plenty of young plaice on the coasts of the Kattegat and of the Great and the Lesser Belt, it was not possible to find one single plaice of the 0-Group on the Baltic shores of Sealand and Falster. On the other hand Dr. Schmidt in the same year in deep water (about 20 metres depth) South of Møen got 17 plaice of the 0-Group, 3—6 cm in length, in the Danish trawl together with 1500 older plaice. Dr. Petersen, however, does not believe in the possibility that the young of the plaice can live and develop in deeper water such as for instance the young of the dab ordinarily do, a view which he had set forth already in 1894 (Rep. Biol. St. IV, page 13). He therefore ends in setting up the following three possibilities, by which the great stock of plaice

*) As a matter of fact Dr. Petersen in Rep. IV mentions the Kattegat and the Belts as the supposed place of origin of these plaice, and by the Belts he understands the waters round Samsø, the Great Belt and the Lesser Belt, and the western Baltic (see Rep. XII, page 4). Thus there is in reality no difference between his and the German authors' views.

in the Baltic proper may be thought to be renewed, either 1) extremely slowly by a very little yearly increase, or 2) by a great increase in some years, the hydrographical conditions being then very different, and the young must then occur in large quantities, or 3) by immigration. As the informations given by the investigations hitherto carried out cannot be said to support any of the two first named possibilities Dr. Petersen firmly adheres to his immigration hypothesis. Also in the following paper, "Über die in den Jahren 1904 und 1905 an der Küsten der Ostsee beobachtete Brut von Plattfischen" (Rapports et Procès-Verbaux. Cons. perm. intern. pour l'exploration de la mer. Vol. V., 1906), Dr. Petersen maintains the same point of view. He gives the result of a cooperation carried into effect on his initiative, of Swedish, German and Danish investigations with the aim of settling the limit of the flat fish brood along the coasts of the Kattegat and the Baltic during the years 1904 and 1905. In spite of eager search from the three countries mentioned*) it was not possible in 1904 to find a single plaice of the 0-Group on the coasts of the Baltic proper and in 1905 only 4 were found altogether (2 at Grønsund, 2 between Darsserort and Rügen); at Bornholm no investigations were made. Evidently the stock of the 0-Group was more numerous in 1905 than in 1904, the last named year seems to have afforded bad conditions for the plaice brood. Having seen from a great number of investigations that every year an important amount of young plaice may be found in the western Baltic, Dr. Petersen thinks that we must regard the German coasts from the East coast of Sleswic till South of Fehmern as the birthplace of those young plaice which provide the main contingent to the stock of plaice of the Baltic proper.

In a paper written by A. Otterstrøm "Eggs and Young of Fishes in the Danish Waters" (Rep. Biol. St. XIII, 1903 and 1904) it is mentioned on p. 45 that 4 pelagic plaice larvae have been found by the Biol. St. (South of Møen) in April 1903; the author, however, thinks that they were brought to that place by the current. From the table p. 78 it is seen that several plaice eggs have been taken in the saline bottom water in the Baltic proper between Falster, Møen and Rügen in January and March 1904, but on account of the infrequent occurrence of the pelagic plaice larvae the author thinks himself entitled to say that neither cod eggs nor plaice eggs as a rule are developed in the Baltic proper (p. 18, the note).

From the German side an extensive work by S. Strodtmann on the fish stock of the Baltic was published in 1906 ("Laichen und Wandern der Ostseefische". II Bericht. Wiss. Meeresunters N. F. VII Bd. Helgoland). On the German Stations in the Baltic in February 1905 he found plaice eggs in the

*) From the German side the results were published by Krüger, Reibisch and Duncker in Mitt. des deutschen Seefischerei-Vereins Nr. 10—11, 1904.

"Bornholm Deep" East and North of Bornholm; further some single pelagic larvae were taken in the Baltic proper in May 1905, a single one was even caught in the Bornholm Deep.

As to the renewal of the stock of plaice he imagines that it takes place in this manner that especially the plaice of the I-Group from the coasts of Mecklenburg-Holstein and of some of the Danish islands very slowly disperse themselves eastwards, when they during the autumn and the following winter look for deeper water and in the following spring move into more shallow water. But on the other hand he does not think that it is necessary to suppose, that the whole stock must be renewed in this way. Certainly the hitherto known catches of pelagic larvae and of bottom stages of the 0-Group have been so very few that they are far from explaining the great quantities of older plaice which have been found both at Møen and at Bornholm, but firstly it cannot be said that the examinations of the occurrence of the 0-Group are sufficient, secondly the older plaice form an "accumulated" ("angesammelter") stock, because there exists neither greater rapacious fish nor any fishery of importance East of Rügen; here, therefore, a slight annual renewal will be sufficient. (Comp. Dr. Petersen's before mentioned "possibility I".)

This view about the plaice stock of the Baltic proper as an accumulated stock of mainly old fish, was confirmed by Dr. A. C. Johansens's determinations of age of 576 plaice, caught in November 1905 South of Møen. The Otolith investigations showed that only 0,5 per cent of the plaice belonged to the I-Group, 8,5 per cent to the II-Group, 5,7 per cent to the III-Group, while 77,8 per cent belonged to the older series from the IV-Group and upwards ("Über die Schollenfischerei in Kategat" etc. Rapp. et Procès-Verbaux etc. Vol. V., 1906).

In 1907 Dr. J. Reibisch (Mitt. d. Deutschen Seefischerei-Vereins. Nr. 2) reported the results of the German investigations on the occurrence of the fry of flath fish on the German Baltic coast in 1905 and 1906. While in 1905 as before mentioned 2 plaice of the 0-Group were taken between Darsserort and Rügen in quite shallow water, the hand push net could not be used there in 1906; but with the seine he got in September in a depth of 12—13 meters 7 plaice of the 0-Group in 2 hauls, and 1 specimen in a depth of 4 meters. His opinion about the renewal of the stock is coincident with Strodtmann's above named dispersal theory.

From the preceding it will be seen that no one of the numerous authors who have discussed the question about the renewal of the plaice stock in the Baltic proper since the matter was raised by Dr. Petersen in 1894 and till the year 1907, has been able to invalidate this author's immigration theory, even if other possibilities also have been indicated, and then before all by Dr. Petersen himself. Johs. Schmidt's find in 1902 of some few specimens of the 0-Group of plaice in deep water causes Dr. Petersen to declare (Rep. Dan. Biol. St. XII,

p. 16), "It is also most likely that the fry is not found in larger numbers, but only singly, and especially towards autumn when it has grown a little larger, in the seas East of Gedser-Darsserort. But this must be confirmed by direct investigations carried on through several years, and we must not be content with looking for the fry along the shores in localities similar to those where it usually occurs. It is possible that the fry can live and develop in deeper water, as, for instance, the common dab usually does. Certainly I do not believe this to be the case, but we must be able to say that this possibility is excluded by our direct investigations, as it is now, in my opinion, in the Danish seas proper." Strodtmann also refers to Dr. Schmidt's above named find, when he (l. c. 1906 p. 193) writes, "Vielleicht hat man die 0-Gruppe an ganz verkehrten Stellen gesucht". In spite of very eager search only half a hundred plaice of the 0-Group had been caught in shallow water on the coasts of the Baltic proper during all the years from 1893 till 1907; on the other hand the 0-Group had not been sought systematically in deeper water, although various investigators had just found it there. Thus Schiemenz in 1901 got 1 plaice of the 0-Group in a depth of 28 meters at Bornholm; Dr. Schmidt in 1902 caught 17 specimens at a depth of 20 meters South of Møen, and Reibisch in 1906 got 7 plaice of the 0-Group at a depth of 12—13 meters between Rügen and Darsserort. It therefore would be obvious then to look for fry in deep water in the Baltic proper; a thoroughly systematical investigation, however, was still wanting.

This work was entertained by Dr. A. C. Johansen. In a paper "Contrib. to the Biology of the Plaice IV. Is the Plaice indigenous to the true Baltic?" (Medd. Komm. for Havunders. Serie Fiskeri Bd. III No. 5, 1908) he gives several new and valuable additions to the knowledge about the occurrence of the plaice fry in the Baltic proper. After having mentioned the earlier investigations he tells how he in 1907 succeeded in catching several plaice of the 0-Group in deep water in the Baltic proper. During the month of March 1907 he caught 226 plaice of the year-class 1906, thus still by name belonging to the 0-Group, as the "birthday" is settled to be April the 1st, but yet obviously about 1 year old; 215 of these were captured in the water between Rügen and Møen—Falster in a depth of 14—18 meters, 7 were taken betwen Rügen and Adlerground on 17 meters depth and 4 at Krüger's Flat on a depth of 30—36 meters. All these plaice were taken by 50 foot Ottertrawl fitted with an iron chain on the ground rope; without this chain it proved to be impossible to fish for the small plaice, the bottom consisting of sand with clusters of mussels. As the author remarks (p. 8) it is the first time that the 0-Group has been found in the Baltic proper in such numbers that it may compete with each of the other annual series (I-Group, II-Group etc.) in richness of specimens; it must, however, be remembered that the "0-Group" here means one-year-old plaice.

During the end of July and the beginning of August 1907 Dr. Johansen made a new investigation of the deep water in the Baltic proper, this time with

a Young fish trawl provided with wings and chain, with the purpose of finding the fry of the year. Although this fishing apparatus was used at 29 stations between Falster and the Middel Bank, and at depths between 8 and 87 meters it was only possible to catch 1 plaice of the 0-Group at the Oder Bank at a depth of 15 meters and 21 plaice of the 0-Group at a depth of 18—21 metres on 3 stations in the water between Møen and Rügen. The fishing time on these 4 stations was in total $8^1/_2$ hours, the mean capture per hour being thus hardly 3 plaice, a rather low figure. However, the author rightly points out (p. 9) that we must not expect to find so many young plaice per m^2 in deeper water as on the coasts, because the first mentioned area is much more extended than the latter where as a rule only a narrow strip is fitted for the occurrence of the fry.

While until 1908 only about a dozen pelagic plaice larvae had been caught in the Baltic proper by all the former investigators together, A. C. Johansen in April—May 1908 succeeded in showing the presence of pelagic plaice larvae practically everywhere in the water between Falster and Bornholm, even so far eastward as north of the Stolpe Bank (16° 35′ E). These larvae were found in water of a salinity right down to 7 ‰, but the frequency of the larvae increased with the salinity; already at 12,5 ‰ the larvae were found in important numbers. In total 155 larvae mere taken in the Baltic proper; a very great part of them evidently were newly hatched, "so nothing suggests that these might have been transported by currents as larvae from the southern Kattegat or the Belt Sea". By quantitative calculations Dr. Johansen finds out that in May 1908 there must have been at least about 909 millions of plaice larvae in the Baltic proper West of 17° E. long. and south of Øland. As presumably only 5—10 millions of plaice are fished here annually, the above named number is comparatively considerable, and Dr. Johansen therefore states: "The find of a numerous 0-Group of plaice in the true Baltic, both of bottom stages and pelagic stages, has invalidated the basis for the immigration hypothesis. From the moment when a considerable 0-Group is found to exist in the Baltic proper we know nothing at all whether the number of bottom stages of plaice immigrating to the Baltic is smaller or greater than that emigrating from the Baltic. The solving of this problem with regard to the older series must now be carried on by means of marking experiments" (p. 13). After having mentioned that the comparatively small size of the plaice of the Baltic proper, both the pelagic larvae and the bottom stages, goes dicidedly against the hypothesis of an immigration of the majority of plaice, while it is possible that some specimens may have immigrated as 0-Group or as I-Group etc., Dr. Johansen finally mentions the results of a marking experiment with plaice East of Falster from which it appears that "the tendency to wander in an eastern direction is not more marked than the tendency to wander in a western direction" (p. 22).

From the paper it is evident furthermore that Dr. Johansen considers the deep water to be the real home of the 0-Group in the eastern part of the Bal-

tic. Thus he writes p. 13, "The specimens (i. e. of the bottom stages of the 0-Group) which are present in deeper water and which form the main stock of the 0-Group in the true Baltic . . .". The same view has been set forth by the same author already in his "Contr. to the Biology of the Plaice III, 1908, p. 6. "The 0-Group of the plaice in the Baltic has its normal distribution in deeper water from ca. 10—ca. 40 meters depth. Thus the 0-Group occurs here together with the I-Gr., the II-Gr., the III-Gr., and so on".

In 1911 Professor J. Reibisch published a paper "Biologische Untersuchungen über Gedeihen, Wanderung und Ort der Enstehung der Scholle *(Pleuronectes platessa)* in der Ostsee" (Wiss. Meeresunters. N. F. Bd. 13 Abt. Kiel) in which he criticises Johansen's above mentioned figures for the number of pelagic plaice larvae in the Baltic and endeavours to show, that it is too small to recruit the whole stock. He comes to the conclusion that an immigration must take place of adult plaice, especially of males, from the Kattegat and the western Baltic to the Baltic proper. It will be seen that this immigration hypothesis, which Reibisch founds on certain peculiarities at the otoliths of some of the Baltic plaice, is somewhat different from the original hypothesis of Dr. Petersen, according to which it should be the younger annual series (especially the I- and the II-Group), which immigrate into the Baltic. In answer of Reibisch's paper A. C. Johansen in 1912 published "Contrib. to the Biology of the Plaice etc. V. The supposed migrations of Plaice from the Kattegat and the Belt Sea to the true Baltic" (Medd. Komm. f. Havunders. Serie Fiskeri, Bind IV, No. 1). He rejects Reibisch's above named objections, criticises his interpretation of the plaice otoliths and insists, referring i. a. to the Danish marking experiments, on his opinion concerning the stock of plaice in the Baltic proper as an endemic stock. In the end of the paper it is mentioned (p. 31) that during the autumn of 1911 there were found unusually big numbers of plaice of the 0-Group in shallow water (1—2 meters' depth) in the Køge Bay; at 5 stations between Copenhagen and Stevns 61 specimens were caught on September 20'—21', and 12 specimens at 1—2 meters depth, 27 specimens at 2—6 meters depth on November 10'—11'. The size of these Dr. Johansen quotes as a proof that no immigration may have happened, at any rate not recently, of the 0-Group from the Sound, where the average size of the 0-Group at the mentioned times was smaller than in the Køge Bay.

Since 1912 no important papers have been published concerning this matter. That Dr. Petersen already in 1909 after Dr. Johansen's find of numerous plaice larvae in the Baltic proper has altered his opinion and now thinks it to be proved that the plaice may propagate there, is mentioned by Dr. Johansen l. c. page 4, the note. Dr. Petersen also agrees with Dr. Johansen's view concerning the question where the bottom stages of the 0-Group are to be found; thus in Rep. Dan. Biol. St. XXIX, 1922, he writes page 27: "It has always been difficult to be sure of the quantity of fry in the true Baltic, as it lives in deep water in contrast to its habit in other waters. The future will perhaps enlighten us upon this subject."

In the recently published Report from the Danish Biological Station No. XXXI, 1925, Dr. Petersen shows in a small paper, "The Influence of Fishing upon the Stock of Plaice in the Baltic during recent Years" that the intense fishery which during the later years has taken place in the Baltic proper, both from the Danish and the Swedish and the German side, has caused the fact that the plaice now are more quick-growing than before; at the same time, however, the stock has been thinned out, the old individuals disappearing gradually, and the stock of plaice therefore now mainly consists of comparatively young individuals. Furthermore he shows how the year-class 1919 dominates over all the other year-classes in a series of samples of plaice, taken South of Møen during each of the years 1921—24. "It may therefore appear as if fry were only plentiful in certain years in the Baltic, but how often this occurs we do not know. Perhaps there is a long interval between such good years, and perhaps the fry do not originate from eggs actually hatched in the Baltic" (page 9). Having mentioned that the 0-Group of plaice has very rarely been met with in any number in the Baltic, and practically never in shallow water near the sandy beaches where in other waters they usually are to be found, Dr. Petersen ends in saying "It would therefore be very desirable if before long the old important question of the renewal of the stock of plaice in the Sound and the Baltic in the years to come might be examined methodically over larger areas". —

II. The Investigations of the Danish Biological Station in the Baltic Proper in 1925.

During April—May and July—August 1925 the present writer working from the Biological Station's steamship »Japetus Steenstrup« made some fishery investigations in the Baltic between the coast of Sealand-Falster and the water round Bornholm. My attention was specially directed upon the occurrence of the younger annual series of the plaice, which were searched for with various gear, both in shallow and in deep water. The determinations of age have all without exception been carried out by the present writer, by means of the otoliths. In addition to the results from 1925 I have in the following included some information concerning the annual series in question, which the Biological Station's investigations have given during the years 1923 and 1924.

Plaice of the 0-Group (Year-class 1925).

In spite of various investigations made with Petersen's young-fish trawl and pelagic nets, we did not succeed in catching pelagic plaice eggs and larvae in the waters round Bornholm at the end of April 1925. On the other hand 3 pelagic plaice larvae of a length of 12 mm were caught 8 miles E. of Gedser in a 15 minutes' haul with young-fish trawl at the bottom, and 5 specimens,

11—13 mm in length, with the same gear S. of Gedser. In all hauls were caught, both at Bornholm and at Falster, important numbers of cod-, Onos- and flounder- (or dab-) eggs, together with some few larvae of these species.

During the months of July and August 1925, however, important quantities of plaice of the bottom stage of the 0-Group were found in the Baltic proper, not only at the coast of Sealand, Møen and Falster, but also at Bornholm. The investigations were carried out partly in shallow water on the shore by means of hand push nets and a seine of canvas handled from a small boat, and partly in deeper water with a fine-meshed otter trawl, or a young-fish trawl with a chain attached to the ground rope, from the steamship. The results are seen in the accompanying lists (Tables 1 and 2).

A. On the Shore.

In 1925 there were found for the first time on the shores of the Baltic proper an 0-Group of plaice in the bottom stage so numerous as to compete with the 0-Group of the adjacent waters (see Table 1).

In the table page 16 an account is given of the duration of hauls, and, although the catch on these shallow shore areas is, also, highly dependent upon such factors as force of the waves, nature of the bottom, transparency of the water, conditions of weather and temperature, yet it is possible roughly to get an estimation of the frequency of the 0-Group in the different places. It will be seen that at Bornholm there were only caught at most 6 plaice of the 0-Group with the push net in half an hour, at Rødvig and Grønsund (Sealand-Falster), on the other hand, about half a hundred specimens were taken during the same period of time; but in the inmost part of Køge Bay and Faxe Bay (Sealand) at most 1 specimen per half an hour. In the places where the push net has given fewest plaice per half an hour, these plaice were however much larger than the average in neighbouring places with many plaice. Thus it will be seen from the table that while the average size of the plaice at Rødvig (48 specimens) and Grønsund (59 specimens) the 3rd and 6th of August respectively was 5,8 and 5,6 cm, the plaice at Dragør (2 specimens) at the same time measured 7,5 cm, at Køge (1 specimen) 9 cm, and at Faxe (1 specimen) 8 cm; at Gjorslev Wood on the southern side of Køge Bay, where in half an hour 13 plaice were taken, the average length was 6,6 cm. It seems therefore to be the rule in these waters that the more sparsely the plaice occur, the greater they are.

It must be observed that during these investigations not a single plaice was caught from other year-classes than 1925.

Together with the plaice a number of flounders were caught, mostly of the year-class 1925, but sometimes also a few of the year-class 1924. Both the frequency and the average size of the 0-Group were largest in the inmost part of Køge Bay and Faxe Bay where conditions accordingly seem to be extraordinarily favourable for the flounder fry. Also some turbot of the 0-Group were

Table 1. The result of the search for plaice of t

	Date	Place	Depth in metres	Gear
Bornholm	25. VII	South of Rønne	1/2—1	Hand push net
	26. VII	South of Nexø	1 1/2—3	Small seine, 5 hauls
	„	„	1/2—1	Hand push net, 2 men in 30 Min.
	27. VII	Sandvig	„	„ „ 15 „
	28. VII	North of Rønne	„	„ „ 45 „
	29. VII	South of Nexø	„	„ „ 135 „
	1. VIII	North of Dueodde	„	„ „ 20 „
	„	Arnager	„	„ „ 20 „
Sealand	3. VIII	Rødvig	„	„ „ 30 „
	5. VIII	South of Dragør	1/4—1	„ „ 30 „
	„	North of Køge	„	„ „ 25 „
	„	„	1/2—3	Small seine, 2 hauls
	„	Gjorslev Wood	1/4—1	Hand push net, 2 men in 30 Min.
	„	„	1/2—2 1/2	Small seine, 1 haul
	6. VIII	East of Faxe Harbour	1/2—2	„ , 2 „
	„	„	1/2—1	Hand push net, 2 men in 30 Min.
	„	Jungshoved	3/4	„ „ 30 „
	29. VIII	Rødvig	1/2—1	„ „ 30 „
Møen	28. VIII	East of Klintholm Harbour	1/2—1	„ „ 20 „
	„	In Klintholm Harbour	„	„ „ 15 „
Falster	6. VIII	Grønsund	1/2—1 1/2	„ „ 30 „
	7. VIII	Rødsand	1/2—1	„ „ 45 „
	27. VIII	Grønsund	„	„ „ 30 „
	„	„	1—1 1/2	Small seine, 7 hauls
	„	Hesnæs	„	Hand push net, 2 men in 30 Min.

In total Plaice of the 0-Group 299 specimens.
„ Flounders „ 4052 „
„ Turbots „ 390 „

Group on the shores of the Baltic proper in 1925.

Plaice			Flounders				Turbots		Soles	
0-Group			0-Group		I-Group		0-Group		0-Group	
mber	Size in cm	Average Size in cm	Number	Size in cm	Number	Size in cm	Number	Size in cm	Number	Size in cm
0			15	$2^1/_2$—4						
1	$4^1/_2$	4,5	11				1	$1^1/_2$		
6	4—5	4,4	190	$1^1/_2$—$3^1/_2$			?			
0			22	2—$3^1/_2$						
1	$6^1/_2$	6,5	140	2—$5^1/_2$			1			
23	$3^1/_2$—5	4,4	2000	2—4	2	8	50	2—3		
3	5—6	5,7	37	$2^1/_2$—4			20	2—4		
0			146	2—5			55	2—$4^1/_2$		
48	4—7	5,8	202	2—$4^1/_2$			20			
2	$6^1/_2$—$8^1/_2$	7,5	33	$2^1/_2$—$4^1/_2$	1	8	64	2—$5^1/_2$		
0			219	$2^1/_2$—7	3	8—9	30	$2^1/_2$—$4^1/_2$		
1	9	9,0	4	4—6	4	8—14				
13	5—8	6,6	59	$2^1/_2$—5	1	8	115	2—$3^1/_2$		
0			2	$2^1/_2$—4			4	2—$3^1/_2$		
0			49	3—6			5	3—4		
1	8	8,0	c. 600	3—$7^1/_2$	1	$8^1/_2$				
0			39	3—7						
67	$4^1/_2$—9	6,2	83	2—6	1	$8^1/_2$	6	$2^1/_2$—$4^1/_2$	1	$2^1/_2$
8										
30	4—$8^1/_2$	6,4	97	$2^1/_2$—$6^1/_2$	2	$11^1/_2$—12	3	$3^1/_2$—6	2	6—7
59	3—8	5,6	44	$2^1/_2$—$5^1/_2$			10	3—$5^1/_2$		
0			28	$2^1/_2$—5			4	3—5		
25	$4^1/_2$—8	5,7	9	3—5			1	5		
11	$4^1/_2$—8	6,0	23	3—$5^1/_2$			1	$4^1/_2$		

Table 2. The result of the search for plaice of the 0-Group in deeper water in the Baltic proper in 1925.

Date	Place	Depth in metres	Gear	Plaice 0-Gr.			Flounders 0-Gr.	
				Number	Size in cm	Average Size in cm	Number	Size in cm
6. VIII	Off Grønsund	11	Otter-Trawl w. 12 Leads 45 Min.	48	4—8	6,1	6	$3^1/_2$—7
27. VIII	„	10—12	„ „ 3 kg Chain 30 „	34	$4^1/_2$—$8^1/_2$	6,1	1	4
„	„	8—12	Youngfishtrawl w. 1,2 kg Chain 40 „	9	$4^1/_2$—8		3	$3^1/_2$—$4^1/_2$
25 VIII	11 Miles N. by E. of Darsserort	18	Otter-trawl w. 3 kg Chain 55 „	239	5—$8^1/_2$	6,2	0	
„	„	„	„ „ 8 Leads 20 „	9	5—$8^1/_2$	6,15	0	
„	„	„	Youngfishtrawl w. 1,2 kg Chain 15 „	16	$5^1/_2$—7	6,05	0	
27. VIII	7 Miles S.W. by S. of Møens Light	$15^1/_2$	Otter-trawl w. 3 kg Chain 40 „	3	$4^1/_2$—6	(5,2)	0	
28. VIII	East of Møen	21	„ „ „ „ 15 „	2	5—$5^1/_2$	(5,2)	0	
„	South of Stevns Light	$19^1/_2$	„ „ „ „ 45 „	43	$5^1/_2$—8	6,7	0	
29 VIII	$1^1/_4$—$2^1/_2$ Miles S.E. by S. of Stevns Light	20—23	„ „ „ „ 60 „	9	6—$8^1/_2$	7,2	5	$4^1/_2$—6
„	N. E. of Magleby Wood (Køge Bay)	14	„ „ „ „ 30 „	3	$5^1/_2$—8	(7,2)	0	

In total Plaice of the 0-Gr. 415 specimens.

taken both at Bornholm and at Sealand-Falster, and 3 soles were caught at Møen and Stevns; the 2 specimens from Stevns, in spite of their important size, 6—7 cm, no doubt were of the 0-Group, like the specimen from Stevns (See A. C. Johansen in Rapp. et Proc.-Verb. XXII, 1915, page 100). As far as known soles of the 0-Group have not previously been caught so far down into the Baltic proper; A. C. Johansen (l. c. page 41) gives the Sound as for as Barsebäck—Strandmøllen and the Neustädter Bay as the southern and eastern limits respectively towards the Baltic.

From the German side shore investigations have, according to kind information to me in a letter from Professor Dr. H. Henking, Berlin, only been carried out on a single place in the Baltic proper, viz. off Gr. Poberow in Pommern. Here Prof. Henking in the course of 10 days (21'—31' July) took with hand push net 101 turbots and 12 flounders, but no plaice. On the other hand 385 young plaice, 194 flounders, 64 turbots and 1 sole were caught on the shores of the Wismar Bay as far as Warnemünde during the months of July and September 1925.

B. Deeper water (see Table 2).

Besides the plaice and flounders of the 0-Group indicated in Table 2 some few plaice and flounders of older series were taken; they will be mentioned later on. Further some dabs, some of them belonging to the 0-Group, some cod of the 0- and I-Group, a few whitings of the 0-Group, and some few turbots, but none of the 0-Group, were caught. In the richest hauls North of Darsserort the plaice of the 0-Group dominated by number over all the other fish. At Bornholm and in the water betveen Bornholm and Møen no plaice of the 0-Group were found in spite of eager search.

It will be seen from the Tables 1 and 2 that the fry of the current year was found in 1925 in large quantities, both on the coast and in certain places in deeper water in the Baltic proper.

Plaice of the I-Group (Year-class 1924).

A. On the shore.

The 24th of July 1924 plaice of the year's fry were sought for with the seine from a small boat on the shore at Grønsund, in the same place where the 0-Group was found in quantities in 1925, but no plaice were caught, only 1 flounder of 2,2 cm's length. On the 2nd of August 1924 another search was made for small plaice on the sandy banks at Gjorslev Wood in Køge Bay, both with seine and push net, but the result again was negative; only 8 flounders of 1,2—2,2 cm's length were found. During the year 1925, besides the numerous investigations on the shores mentioned above, search has been specially made for the I-Group at Rødvig and at Grønsund, on the 28th of April and the 3rd of May respectively. Notwithstanding this only one single plaice of the I-Group was

caught in all the investigations on the shores of the Baltic proper in 1925, viz. in the above named place in Grønsund. Small plaice were sought for here on the 3' of May under favourable conditions by two men with the push net for 3 hours. The result was in total only 1 plaice of the I-Group, 5 cm in length, but 18 flounders of the I-Group, 3—5 cm in length, and 13 plaice of the II-Group, 7—12 cm in length. A haul with Ammodytes-seine from a small boat gave only 1 plaice of the II-Group and 1 large flounder.

B. Deeper water.

During the year 1924, in the end of June and the beginning of July, there was fishing at Stevns and off Grønsund for plaice of the year's brood, in both places, however, without success. On the other hand on August the 2' 1924 we succeeded in catching, off Stevns at 24 metres depth, 4 individuals of the year's brood, partly with a small-meshed otter-trawl (2 hauls in 70 minutes), partly with Ammodytes-seine (2 hauls in 20 minutes); they measured 4—5 cm. During the spring of 1925 the I-Group was sought for, both North of Darsserort and East of Gedser at 17—18 metres depth, in the same places where Dr. Johansen in 1907 took 119 and 39 plaice respectively, of the year-class 1906; the result, however, was very poor, although a chain was attached to the ground rope of both otter-trawl and young-fish trawl, since only one of all the small plaice taken here on May the 4th and the 5th might possibly belong to the I-Group; the rest belonged to the II-Group and older series. Neither off Grønsund at 12 metres depth, nor South of Gedser at 22 metres depth, were any plaice of the I-Group found. During the Summer and autum of 1925 there were in the numerous investigations with otter-trawl and young-fish trawl undertaken in deeper water in the Baltic proper, only caught in all 16 plaice which possibly might belong to the I-Group, together with a number, many times larger, of plaice of the 0-Group and the II-Group. The size was 9—12 cm. At Bornholm it was not possible to find one single plaice of the I-Group in 1925, in spite of eager search.

Thus we are fully entitled to conclude that the year-class 1924 has failed almost completely in the Baltic proper.

Plaice of the II-Group (Year-class 1923).

A. On the shore.

During the year 1923 no search was made from the Danish Biological Station for plaice-young on the shores of the Baltic proper, and at the two above mentioned shore investigations in 1924 no plaice were caught. But during the spring of 1925, on the 21st of April, 1 plaice of the II-Group, 10 cm in length, was taken, together with 65 flounders of the I-Group, 2 of the II-Group, and 1 turbot of the I-Group. Two men fished here with hand push net during 1 hour.

Table 3. Catch of plaice of the year-class 1923 (II-Group) in the Baltic proper in 1925.

Date	Place	Depth in metres	Gear	Plaice of the II-Group		Besides caught plaice of		
				Number	Size in cm	Group	Number	Size in cm
20. IV	15 Miles South of Rønne	36	Otter-trawl 30 Min.	45	6–16	III—IX	102	16—32
24. IV	14 Miles S. S. E. of Rønne	36	„ 45 „	8	7—16	III–IX	18	19—32
28. IV	$2^1/_2$ Miles S. E. by E. of Stevns Light	22	„ 30 „	1	9	IV—V	2	27, 35
»	S. W. of Rødvig	13	„ 75 „	18	8—14	III—VII	62	14—31
4. V	11 Miles N. $^1/_2$ E. of Darsserort	17—18	„ w. 1,6 kg chain 75 „	7	9—10	I, IV, VI	1 + 4 + 1	6, 19—32
»	„	„	Yung-fish trawl w. 1,2 kg chain 30 „	5	9—10		0	
»	E. S. E. of Hestehoved	22	Otter-trawl 15 „	3	9—12		0	
5. V	8 Miles E. of Gedser	17	„ w. 10 Leads 30 „	3	10—11		0	
»	S. of Gedser	22	„ „ 30 „	7	7—11	IV, VII	2	26, 30
20. VI	S. W. of Rødvig	13	„ „ 15 „	15	10—22	III, IV	13	20—26
3. VII	N. E. of Magleby Wood (Køge Bay)	14—18	„ „ 130 „	13*)	20—26	III—cXII	29	23—36
25. VII	15 Miles S. of Rønne	36	„ w. 16 Leads 70 „	6	8—12	III—cX	30	17—39
1. VIII	„	„	„ „ 90 „	36	10—16	III—cX	114	15—31
„	14 Miles S. S. E. of Rønne	43	„ 20 „	20	8–17	III—IV	22	17—31
3. VIII	Køge Bay	$12^1/_2$	„ 68 „	6	17—25	I, V, X	1 + 1 + 1	10, 28, 39
5. VIII	$1^1/_2$-$2^1/_2$ Miles S. E. by S. of Stevns Light	$22^1/_2$	„ 30 „	24	14—24	I, III	2 + 3	11, 22—28
25. VIII	11 Miles N. by E. of Darsserort	18	„ w. 3 kg chain 55 „	4	10—13	0, I	239 + 2	5—10
„	„	„	„ „ 8 Leads 20 „	1	12	0	9	5—8
27. VIII	Off Grønsund	11—12	„ „ 3 kg chain 30 „	10	11—23	0	35	$4^1/_2$–$8^1/_2$
28. VIII	S. of Stevns Light	$19^1/_2$	„ „ „ 45 „	20	11–27	0, I, IV	43 + 2 + 1	$5^1/_2$–8, 10, 27
29. VIII	$1^1/_4$-$2^1/_2$ Miles S. E. by S. of Stevns Light	20—23	„ „ „ 60 „	8	12—21	0, III, IV	9 + 1 + 3	6–$8^1/_2$, 25–28
„	N. E. of Magleby Wood (Køge Bay)	14	„ „ „ 30 „	7	19—24	0, III-XII+	3 + 6	$5^1/_2$-$8^1/_2$, 25-37

In total Plaice of the II-Group 266 specimens.

*) Determination not sure in 4 individuals.

In addition it has been mentioned above that 14 plaice of the II-Group, 7—12 cm in length, were taken on the shores of Grønsund on May the 3rd, 1925.

B. In deeper water.

Although no special investigation of the frequency of the 0-Group was carried out in 1923, plaice of this group were taken twice from the Dan. Biol. Station in the Baltic proper. Thus South of Falsterbo Light-vessel, 29 1/2 metres depth, on August the 9th: 1 specimen, 6 cm in length; and 10—11 miles South of Hestehoved, 18 metres depth, on August the 15th: 4 specimens, 5—8 cm in length.

During the year 1924 the year-class 1923 appeared to be frequent in the Baltic proper. Thus we got South of Stevns, 19—24 metres depth, on June the 26th 5 plaice of the year-class 1923, 6—9 cm in length, in 3 hauls with the otter-trawl, 15 minutes each haul. Furthermore off Grønsund, 7—11 metres depth, on July the 24th 1924 in 2 hauls with the otter-trawl in 15 minutes: 16 plaice of this series, 7—12 cm in length; off Stevns Ligth-house on August the 2nd at 24 metres depth in 2 hauls with otter-trawl in 70 minutes and 1 haul with Ammodytes-seine in 10 minutes: 67 plaice of the year-class 1923, 6—11 cm in length. Finally South of Møen at 22 metres depth on August the 5th and the 16th 1924 in 2 hauls in 30 minutes: 1 plaice of this year-class in each haul; the size was 8 cm.

During the year 1925 the year-class 1923 was likewise found in several places and in important quantities in the Baltic proper (see Table 3).

In all those places where any young plaice at all have been found in deeper water, the year-class 1923 has appeared to be especially well represented; in particular it dominates numerically over the year-classes 1924 and 1922. The size of the plaice of this year-class was smallest at Bornholm South of Rønne, where the largest inviduals of the 0-Group were nearly as great as the smallest inviduals of the II-Group; the otoliths, however, plainly show the odd fact that the I-Group was completely missing here, whereas the 0-Group and the II-Group were numerous.

Plaice of the III-Group and older (Year-classes 1922 and earlier).

As might be expected no plaice of these older series have been found on the shore in 1925. From investigations in deeper water round Bornholm it appeared that the year-class 1922 was comparatively slightly represented, 1921 being, on the contrary, numerous. The same was found to be the case in many other places in the Baltic proper in 1925, and it is confirmed by the investigations in 1924. In the accompanying Table 4 I have put down the number of plaice of the different series taken during the investigations in 1924 and 1925.

As will be seen it has not been possible to determine the age of some few of the plaice; their number is, however, so small that the omission of these cannot have much influence upon the numerical proportion between the annual series.

Table 4. Age of the plaice in the Baltic proper in 1924 and 1925.

Date	Place	Depth in metres	Gear	Year-class					Older	Age indeterminable
				1924	1923	1922	1921	1920		
1924. 1.VIII	Køge Bay	14	Otter-trawl 60 Min.			1	16	23	12	2
„ 2.VIII	Off Stevns Light	24	„ 70 „ / Ammodytes seine 20 „	4	67	3	37	41	8	
1925. 20. IV	15 Miles S. of Rønne	36	Otter-trawl 30 „			5	31	12	9	
„ „	„	„	„ 60 „		45	35	68	6	2	
„ 21. IV	4 Miles E.S.E. of Christiansø	94	„ 45 „				27	16	23	
„ 22. IV	4 Miles N. of Christiansø	84	„ 45 „				6	2	6	
„ „	11 Miles N.E. by. N. of Hammeren.	83	„ 30 „				17	2	42	1
„ 24. IV	12—13 Miles S.E. of Rønne	31	„ 30 „			6	30	9	7	
„ „	14 Miles S.S.E. of Rønne	36	„ 45 „		8	4	10	1	3	
„ 25. IV	32—54 miles. W. $^1/_2$ S. of Rønne	36—56	„ 120 „			1	8	2	4	
„ 28. IV	S.W. of Rødvig	13	„ 75 „		18	17	29	14	2	2
„ 4. V	11 Miles N. $^1/_2$ E. of Darsserort	17—18	„ 75 „	1	12		4		1	
„ 3. VII	N.E. of Magleby Wood (Køge Bay)	14—18	„ 130 „		13	5	14	3	7	
„ 4. VII	8 Miles S.E. of Stevns Light	24	„ 80 „		1	4	18	8	26	6
„ 25.VII	15 Miles S. of Rønne	36	„ 70 „		6	2	10	4	14	
„ 1.VIII	„	„	„ 90 „		36	36	53	6	9	
„ „	14 Miles S.S.E. of Rønne	43	„ 20 „		20	8	9	2		
			Total number	5	226	127	387	151	175	11

The table plainly shows that the year-class 1921 is everywhere much more numerously represented than the year-class 1922. Also in comparison with the one year older plaice (year-class 1920) the figures of 1925 might appear to indicate a domination of the year-class 1921; this, however, is not quite certain, as the fishery in a higher degree falls upon the older series rather than upon the younger ones and thus may have influenced the numerical proportion; besides the figures of 1924, if anything, seem to indicate that there have been at that time more plaice of the year-class 1920 than of the year-class 1921. As to the year-class 1919 Dr. C. G. Joh. Petersen (l. c. 1925) has shown, as above mentioned, that this series dominated all the others South of Møen during the years 1921—24.

Thus we have seen that the year-classes 1925, 1923 and 1919 have been richly represented in the Baltic proper, whereas the year-class 1924 was found to be almost missing, and the year-class 1922 to be very poorly represented. Furthermore, that a numerous 0-Group was found to exist practically everywhere on the coasts of the Baltic proper in 1925. These facts in ny opinion can only be understood if we abandon the immigration hypothesis as well as Dr. A. C. Johansen's theory that the development of the young takes place in deep water. I shall in the following further prove this.

III. The Renewal of the stock of Plaice in the Baltic proper takes place by the Appearance of young Plaice at the Coasts, but is very irregular, being plentiful only in some years and almost completely missing in other years.

Since the last paper by Dr A. C. Johansen on the stock of plaice in the Baltic proper (1912) his view, that a renewal of this stock takes place every year by the appearance of an 0-Group whose main part normally develops in the deep water, has been the ruling. His arguments are the following:

1) Hitherto only relatively few plaice of the 0-Group have been taken on the shores.

2) The author (A. C. J.) however, has found a numerous 0-Group of the bottom stage in deep water in the Baltic proper.

3) The size of this stage is on an average smaller than the size of the bottom stages in shallow water, which fact, according to the writer, suggests that these plaice from the beginning of their bottom stage have been living in deep water (Medd. Komm. f. Havunders. Serie Fiskeri Bd. III Nr. 5, 1908. Pages 14—16).

As to point 1 it must be remarked at first that the number of specimens of the 0-Group found in previous years possibly must be raised a little, because

nearly all the plaice numbered by Th. Mortensen (l. c. 1896, page 57) among the I-Group very well may have belonged to the 0-Group; if we, namely, compare the size of Dr. Mortensen's plaice with the size of plaice of the 0-Group taken by the present writer in 1925, it will be seen that only one single specimen of the former measured more than 6,5 cm, which I found to be the maximum size for plaice of the 0-Group at Bornholm; the rest, 7 individuals in 1894 and 8 in 1895, thus possibly are gained for the 0-Group. So we get the following number of plaice of the 0-Group from the shores of the Baltic proper:

1893	1894	1895	1902	1903	1904	1905	1906	1911	1925
4	33	9	0	1	0	9	8	100	299

According to the above only 64 plaice of the 0-Group in total have been taken during all the years 1893—1906, but in 1911 (in Køge Bay alone) 100 specimens, and in 1925 299 Specimens. The value of the figures, however, highly depends upon whether a really systematic search has been carried through in the right season of the years in question. And so far as may be seen from the literature at hand, this has been the case only in the years 1893, 1902, 1904 and 1905. These years therefore must be supposed to have been relatively unfavourable years for the development of the 0-Group in the Baltic proper, especially 1902 and 1904. With respect to the last named year Dr. A. C. Johansen (Medd. Komm. f. Havunders. Serie Fiskeri Bd. III Nr. 4. 1908) has shown that it was a specially unfavourable year in the central and southern Kattegat and the Belt Sea; Sandmann (Rapp. & Proc.-Verb. V, 1906) found that the fry of the turbot in 1904 was almost entirely missing on the Finnish shores, whereas is was numerous in 1903 and 1905. Also 1893 and 1895, in which years we had severe ice winters, surely have been unfavourable (A. C. Johansen l. c. page 44), whereas 1894, in which year 26 plaice of the 0-Group were taken in one place at Bornholm, probably has been favourable. The same may rightly be said about 1911 when Dr. Johansen in the Køge Bay took 100 plaice of the 0-Group. On the other hand 1912 probably was a bad year, as is seen from the shore investigations of the above named author (Medd. Komm. f. Havunders. Serie Fiskeri, Bd. IV, Nr. 4, 1913, Fig. 10) that not a single plaice of the 0-Group was caught in July 1912 at 8 stations in the Køge Bay.

All these facts thus tend to show that there in former years, too, has been a pronounced fluctuation between favourable and unfavourable years for the appearance of the plaice fry on the shores of the Baltic proper, and that the relatively small result from the researches in 1893—1906 was due partly to unfavourable years, partly to incomplete investigations.

As to point 2 I have already pointed out above (page 12) that Dr. A. C. Johansen in 1907 only took 22 plaice in all of the bottom stage of the year's brood in deep water; the rest, although theoretically to be designated as 0-Group, in reality were 1-year-old plaice, born in 1906. The fishing time for these 22

plaice was no less than $8^1/_2$ hours, and the year's brood was only found in 4 stations, the search in 25 other stations being without result. A. C. Johansen (Contrib. to the Biol. of the Plaice IV, page 9) ascribes this poor result to the nature of the sea bottom (sand with mussels); it will, however, be seen from the age determinations (partly published in the same author's Contributions etc. III, page 14) that there were taken in the same hauls an important number of older plaice; the I-Group especially was far more numerous than the 0-Group, more than 200 individuals of this former group being caught; the above mentioned explanation, therefore, seems hardly reasonable. Thus, even if we take into consideration that the 0-Group certainly occurs more scattered in deep water than on the coasts, we cannot say that Dr. Johansen has found a numerous stock of the year's brood in deep water in the Baltic proper. On the other hand he has, in March, July and August 1907, found a relatively much more numerous stoch of the fry from 1906. These facts can scarcely be explained in any other way than the following: 1906 was a favourable year for the plaice fry in the Baltic, 1907 a relatively unfavourable. I have no doubt that if Dr. Johansen during the autumn of 1906 had searched for the year's fry on the shores of the Baltic proper, he might have found them there in important quantities; unfortunately such shore investigations were not carried out in 1906 (see A. C. Johansen in Medd. Komm. f. Havunders. Bd. III. Nr. 4, 1908, page 21, Fig 4); investigations in March 1907 in 2 places on the eastern coast of Falster and in August 1907 in 2 places on the southern coast of Møen gave a negative result.

If the plaice of the 0-Group found by Dr. Johansen in deep water had been quite young, i. e. if they had recently reached the bottom stage, they would in spite of their small number have had a convincing effect; they were, however, caught as late as the end of July and the beginning of August, thus being at least 4 months old. Catches of the year's brood in deep water in the autumn are, however, very common everywhere in our seas. It is a well known fact that plaice of the 0-Group at that time of the year gradually leave the shallow water on the shores in search of deeper water. Therefore a proof is demanded to show that the above mentioned plaice of the year-class 1907, which were about 4 months old, not to mention the more than 11 months old plaice of the year-class 1906, have developed into the deep water and thut they do not originate from the shores. Thereby we arrive to point 3 of Dr. A. C. Johansen's arguments.

Dr. Johansen states (l. c. 1908, page 15) that while in the North Sea, the Kattegat and the Belt Sea the size of the plaice of the 0-Group and the I-Group on an average increases with the depth, he has found the reverse to be the case in the Baltic proper. In support of this he quotes (l. c. page 16) the average size of the plaice of the 0-Group found in previous years both in deep and shallow water; but while the plaice from the shallow water are from the years 1893—95 and 1903—06, the plaice from the deep water were caught in

other years, viz. 1901, 02 and 07; furthermore the plaice from the shallow water were caught in many different places on the shores, and often only single specimens. The size of the plaice of the 0-Group varies, however, very considerably, not only from year to year, but also from place to place; this is easily seen by looking through Table 2 in A. C. Johansen: „Dritter Bericht über die Eier, Larven und älteren Stadien der Pleuronectiden in der Ostsee etc." (Rapp. et Procès-Verb. Vol. XIV, 1912). As an example the following average sizes of the 0-Group from the shores of the western part of the Great Belt may be cited (l. c. page 10—11).*)

Table 5. Average size of plaice of the 0-Group from the Great Belt, according to A. C. Johansen.

1911, 4' Septbr.	From Bøgebjerg to the South.	7,4 cm	(33	specimens)
1902, 28' Aug.	Kerteminde Bay	7,45 »	(125	»)
1911, 4' Septbr.	» » off Hverringe	6,5 »	(19	»)
» , »	From Risinge Hoved to the South	6,1 »	(31	»)
» , 3' »	Off Skabo Huse	5,6 »	(54	»)
1902, 21' Aug.	» Holckenhavn.....	5,45 »	(89	»)
1911, 3' Septbr.	From Kløverhage to the North	5,0 »	(100	»)
» , 2' »	N. of Lohals Harbour	6,5 »	(24	»)
1902, 28' Aug.	At Lundeborg	6,85 »	(58	»)
1911, 1' Septbr.	» »	7,3 »	(105	»)
» , »	Off Tidselholt	7,8 »	(27	»)

It is clearly seen from this 1) that the average size of the 0-Group in 1902 was other than in 1911 both in Kerteminde Bay, Nyborg Fjord and at Lundeborg, 2) that there was a difference in the average size of up to more than 2,8 cm in even quite neighbouring places in the beginning of September 1911. Above (page 15) I have emphasized that also in the Baltic proper the average length of the 0-Group was found to vary very considerably in neighbouring places of the shores, and that this fact seemed to be connected with the density of the stock; the figures from the Great Belt in Table 5 tend to show the same.

In Rapp. et Procès-Verb. XIV, 1912, page 5, A. C. Johansen indicates the low salinity as the cause of the fact that plaice of the 0-Group have a more slow growth in the western Baltic than in the rest of the Belt Sea. It is, however, evidently a complex of factors which determine the rate of growth, viz.

1) How early in the year the plaice reach the bottom stage. This again depends in a great measure upon the temperature in the sea during the

*) The corrections to the average size, quoted in Johansen's table, are in my table added to the average.

first months of the year; thus Mag. sc. P. L. Kramp (Medd. Komm. f. Havunders. Ser. Fiskeri Bd. VII Nr. 6, 1924) has shown that in the Great Belt the maximal spawning of the plaice which commonly takes place in February, was retarded until the middle of March in the year 1922; this fact he connects with the relatively low temperature in the sea on account of the severe ice-winter 1921—22. After the mild winter 1924—25, on the other hand, the plaice reached the bottom stage relatively early, which I think has been the cause of the fact that I found so few pelagic plaice larvae in the Baltic in the end of April 1925, and a concurrent cause of the relatively important size of the 0-Group in 1925. Thus the average size of 23 plaice of the 0-Group from the shore South of Nexø (Bornholm) was 4,4 cm on July the 29th 1925; but in 1894 26 plaice of the same group and from the same place, taken a month later in the season (30th—31st August), measured only 4,1 cm. Likewise the plaice of the 0-Group taken by me in deep water in 1925 were much larger than those caught by A. C. Johansen in 1907; this is easily seen by comparing table 2, page 18 in this paper with table 2 in A. C. Johansen's paper (Contrib. etc. IV) from 1908.

2) The quantity of food at hand. This again is partly dependent upon the density of the stock; a great density with otherwise similar conditions will restrict the growth, and vice versa*)

3) The salinity, as emphasized by A. C. Johansen, and, finally,

4) The temperature in the shallow water during the summer months.

All these factors are of course highly variable, not only as to different localities, but also from one year to another.

If we, therefore, with A. C. Johansen, compare the average size of the 0-Group in shallow water with that of the 0-Group in deep water, it is necessary to use material from the same year and, furthermore, to compare the 0-Group from the shore with the 0-Group found off this shore in deep water.

From the material of 1925 we get the figures put down in table 6.

In this table three catches at Møen and in Køge Bay have been omitted, comprising respectively 2, 3 and 3 plaice, as such small numbers cannot give any reliable average size. The localities to be compared are placed next each other in the table; it will be seen that the 0-Group from the deeper water has in all cases a larger average size than the 0-Group from the shore, thus the opposite of the result arrived at by A. C. Johansen, and it must be noted that now far better and more extensive material is at hand than that which Dr. Johansen had at his disposal in 1908. It may be remarked that the difference in size is not produced by the fact that a more open-meshed apparatus (Otter-trawl) has commonly been used to catch the 0-Group in deep water, and a more small-meshed (Hand push net) on the shores; several control experiments

*) Comp. A. C. Johansen in Rapp. et Procès-Verb. V, 1906, page 86, on the overpopulation of young plaice in the Nissum Broad (Limfjord) and at Horns Reef.

Table 6. Comparison between the Average Sizes of Plaice of the 0-Group from shallow water and from deep water in the Baltic proper 1925.

Shallow water on the shore.					Deep water.				
Date	Place.	Depth in metres	Number of plaice of the 0-Group	Average size	Date	Place.	Depth in metres	Number of plaice of the 0-Group	Average size
6. VIII	Grønsund.	1/2—1 1/2	59	5,6 cm	6. VIII	Off Grønsund	11	48	6,1 cm
27. VIII	Grønsund.	1/2—1 1/2	25	5,7 „	27. VIII	Off Grønsund	10—12	43	6,1 „
27. VIII	Hesnæs...	1—1 1/2	11	6,0 „	25. VIII	11 Miles N. by E. of Darsserort	18	264	6,2 „
29. VIII	Rødvig ...	1/2—1	67	6,2 „	28. VIII	South of Stevns.....	19 1/2	43	6,7 „
					29. VIII	2 1/2 M. S.E. by S. of Stevns Light	23	9	7,2 „

in deep water with the young fish trawl which is a still more small-meshed apparatus than the push net, shoved that our otter trawl caught even the very smallest specimens of the 0-Group.

Dr. Johansen himself writes (Medd. Komm. f. Havunders. Bd. III, Nr. 5, 1908, p. 16) „If we find, during an investigation, that the specimens of the 0-and I-Group etc. on an average increase in size with the depth in most of our waters, the majority of the specimens captured in deeper water (e. g. 10—20—30 meters) originate probably from the coasts." According to this the main part of the specimens of the 0-Group from deep water found in 1925 in the Baltic proper must be supposed to originate from the shores. In favour of this are, further, the following observations,

1) The 0-Group in deep water was only found in some few limited areas, especially such ones where there was a hard, sandy bottom, sloping off evenly from the shore. The 264 plaice of the 0-Group thus were caught on the great sandy plain which extends from the German coast at Darrs to the North, with evenly increasing depths and hard sand bottom*). If we were to fish a little farther northward, where the depths become greater and the sand bottom more soft, the number would decrease; in spite of eager search no single plaice of the 0-Group was to be found in the large basin South of Møen where the bottom is soft and the depths exceed 20 meters. Off Grønsund we have another limited area, well fitted for young plaice; only 3/4 miles to

*) It would therefore have been best if we had been able to compare the size of these plaice with that of plaice from the shore at Darss; as it was, however, impossible to get any plaice from Darss, I have in the table used the figures from the shore of Falster.

the East, where the depth is 18 meters and the sand more soft, no plaice of the 0-Group were caught. Also at Stevns the catches of the 0-Group took place only on a sandy bottom and in relatively slight depths; in the great soft-bottomed area between Bornholm and Sealand no single plaice of the 0-Group vas caught*).

2) At Stevns and in Køge Bay no plaice of the 0-Group were caught in deep water in July and the beginning of August 1925, though fishing took place in almost the same places where later in the year we got many specimens of the 0-Group.

3) At Stevns, where we in August 1925 took a series of hauls from the coast outwards, we got most plaice of the 0-Group nearest to the coast.

All the facts at hand thus tend to show that the main part of those plaice which during the autum can be found in deep water in the Baltic proper, originates from the shores. As long as the quite young bottom stages have not been found in deep water there is no ground for the theory of Dr. A. C. Johansen that the main part of the 0-Group is developed in the deep water.

On the other hand the find of the numerous stock of the year's fry practically everywhere on our Baltic shores in 1925 has confirmed the correctness of the view of Dr. A. C. Johansen as to the untenability of the old immigration hypothesis. Thus only the possibilty remains which both Dr. Petersen and Dr. Mortensen have previously pointed out, that the stock of plaice in the Baltic is renewed by the appearance of fry on the shores, but only abundant in certain years. All the facts concerning this matter go to show that this view is correct: the highly varying quantity of fry during the different years, the uneven age composition of the whole stock, and the almost total absence of single annual series. But what is the reason of these violent fluctuations in the quantity of fry, and how frequent are the good years? In the following chapter I shall enter into these questions at greater length.

The Causes of the Variations in the Amount of Young Plaice.

Dr. Petersen already remarks (l. c., 1905, page 19) that if the stock of plaice in the Baltic proper must be presumed only to receive a large increase in certain years, the hydrographical conditions in these years must have been very different

*) In a paper by A. R. Molander: Undersøkningar över Rödspätta, Flundra och Sandskädda i södra Østersjön (Svenska Hydr.-Biol. Komm.'s Skrifter. Ny Serie, Biologi. Bind I, Nr. 1, 1925) a large material of flat-fish fished in deep water in the Baltic proper during 1913-23 is found. It appears from his tables that many quite small dab, 3—10 cm in length, have been caught, but no quite small plaice or flounder. Although his fishing gears thus have been able to catch quite small flat-fish, he has not been able to find any small plaice during his numerous fishing experiments in deep water round Bornholm. From his, comparatively few, age determinations it is seen that Molander (like this author) has found no plaice less than two years old in these waters.

from those prevailing in the other years. Dr. Johansen has shown (Medd. Komm. f. Havunders. Serie Fiskeri Bd. III, Nr. 4, 1908) that the severe ice winters in 1893 and 1895 were followed by a very slight frequency of the plaice fry, at any rate in certain parts of the Belt Sea; further, that in 1900 and 1904, in which years an unusually low salinity was found in the surface layers of the Kattegat and of the Belt Sea during the 3 first months of the year, i. e. the period in which the main part of the plaice fry is in its pelagic stage, the 0-Group on the shores of the Kattegat and the Belt Sea was less numerous than normally. The same author in Rapp. et Procès-Verbaux Voll. XXII, 1915, has compared the diviations of the salinity of the surface water from the mean during the months January and February 1905—06 and 1909—13 with the results of the quantitative fishery for plaice of the 0-Group in the same years in the southern Kattegat and the Belt Sea; here, too he finds a certain correspondence between a high salinity and a numerous 0-Group, excepting for the year 1906, during which year only comparatively few investigations were made.

Thus it is obviously necessary to examine how the real facts are in the Baltic proper, the more so because the salinity here is so low that it must be supposed sometimes to go below the minimum necessary for the pelagic stages of the plaice. A. C. Johansen states (l. c. 1908, page 43) that pelagic plaice eggs still at a salinity of 10 $^0/_{00}$ have been found floating in the Baltic, and that plaice larvae have been found in water of a salinity of only 7—8 $^0/_{00}$, but that favourable conditions for the development of the pelagic stages do not occur until far higher salinities are reached

The average salinity or temperature per month as used by Dr. A. C. Johansen does not, however, appear to be any trustworthy basis for a judgment of the conditions prevailing for the fry during the said period. The average is, namely, often something quite different from the mean frequency, which in this connection is of far more interest. If as an example the salinity or the temperature during the first week of a month has been considerably below the normal, but during the rest of the month has been constantly a little above the normal, the mean for the whole month very well may happen to lie below the normal, in spite of the fact that the conditions in reality have been favourable for the eggs and the fry during the main part of this month. We must, therefore, take into account whether the hydrographical conditions have been constant during a longer period, or whether they have varied considerably within short periods.

Considering this I have, instead of giving a series of figures which possibly are misleading, preferred to give in words a general view of the hydrographical conditions in the Baltic during the months January—April of various years. The representation is based upon the „Nautical Meteorological Annual"s daily observations of temperature and salinity from the light ships at the entrances to the Baltic proper, as also from the coast stations in this sea. As it is

known, the pelagic stages of the plaice are most frequently found in the bottom water; I have, therefore, especially considered the conditions into this stratum.

To the working out of the following summary I have mainly used the observations from the light ships at Lappegrunden, Drogden and Gedser Rev, and from the coast stations Rødvig, Klintholm and Christiansø; to judge the fluctuations of the salinity I have taken as normals the means of the months January-April during the last 25 years, kindly placed at my disposal by Capt. C. Speerschneider, of the Nautical section of the Danish Meteorological Institution.

In 1925 both temperatures and salinities were most frequently above the normal during the first 4 months of the year, especially in January and February. No doubt this has been of great importance for the development of the eggs and fry of the plaice, and has to a considerable extent been conducive to the fact that 1925 was an unusually good fry-year (i. e. a year in which particularly many individuals of the bottom stage of the 0-Group were developed).

In 1924 there was, in January, February and March, much ice in the Belts and the Baltic. The temperature, therefore, fell considerably below the normal. For these months we have, however, only very few observations, the light ships being frequently absent from their stations on account of the ice. In April the salinity, especially at the bottom, most frequently kept far below the normal; the temperature, too, was still very low. This is thus in conformity with the fact that 1924 became a poor fry year for the plaice in the Baltic. It may be mentioned here that the investigations in 1925 showed that also in the Belt Sea and in the southern Kattegat the year-class 1924 was very poorly represented; not until the northern Kattegat (Læsø—Skagen) was this year-class found in any quantity.

In 1923 there vas only ice in the Kattegat and the Sound on the 18'—22' February; the temperature of the water, therefore, was most frequently above the mean during the first month of the year; the salinity which in the beginning of January was very low, rose in the end of the month and in the beginning of February to above the normal; from this time, however, it fell below the mean; in the middle of March the salinity of the bottom water increased very considerably, being above the average at Gedser Rev, Drogden and Lappegrunden, but decreased again in April. According to „Bulletin Hydrographique" for 1920—23 and 1924 (Cons. Perm. Intern. pour l'Expl. de la mer) by I. P. Jacobsen measurements of the salinity were made in different depths at Christiansø during the years 1923 and 1924; it is seen from these observations that the salinity near the bottom constantly was about 1,5 $^0/_{00}$ higher in 1923 than in 1924 at the corresponding time of the year. In conformity with this 1923, as stated above, became a very favourable year for the plaice fry in the Baltic proper, as also in the Belt Sea and the southern Kattegat. Furthermore it may be noted that in this year crabs and star-fishes were found far down in the Baltic, and that haddock fry was caught in quantities in the Belt Sea and the western parts of the Baltic.

In 1922 the ice remained in the Kattegat, the Belt Sea and the Baltic from the end of January until well into the month of March; the temperature in the water, therefore, became very low. The salinity, too, was relatively low in January (in February observations from the light ships were lacking); it grew, however, high in the first days of March, but fell again below the normal in the last half of the month. In April it was constantly very low at Drogden and on the surface at Gedser; on the other hand some saline bottom water passed Gedser Rev. It is mentioned above that P. L. Kramp has observed that the spawning of the plaice in the Great Belt this year took place later in the year than normally; it has also been stated page 22 that plaice of the year-class 1922 were found to be relatively poorly represented in the Baltic, so that everything goes to prove that this year has been a less favourable year for the plaice fry.

In 1921 a large quantity of relatively saline and warm water came into the Baltic during the first 4 months of the year; it has been mentioned page 23 that this year-class was very numerously represented in the Baltic.

In 1920 the temperature was about normal, the salinity most frequently a little below the normal; as stated above (page 24) the V-Group in 1925 was less numerously represented; we are, however, not able to draw any conclusion from this as to 1920 being a good fry year or not. According to the coast investigations of A. C. Johansen in 1921 („On the Density of the young Plaice Population" etc. Medd. Komm. for Havunders. Serie Fiskeri, Bind VI, No. 8, 1922) the year-class 1920 appears to have been rather more numerous than the year-class 1921 in the Belt Sea.

In 1919 there came an influx of very saline water from the Kattegat in the first 4 months of the year. This year must have been especially favourable for the plaice fry in the Baltic proper, as Dr. Petersen (see page 14) found the year-class 1919 predominating in numbers throughout a series of years.

As to the years 1913—18 nothing is known about the frequency of the plaice fry on the Baltic shores.

On the other hand it has been mentioned above, that the shore investigations of A. C. Johansen in 1911 and 12 tend to show that 1911 was a favourable year for the plaice in the Baltic proper, but 1912 an unfavourable one. In agreement with this it is seen from statistical information that there came an inflow of relatively warm and saline water to the Belt Sea and the Baltic during the first months of the year 1911; 1912, on the contrary, began with a severe ice winter and had in January and March (the February-observations were impeded by ice) very low salinities at Gedser Rev. Also the curves in the above mentioned paper by A. C. Johansen (Rapp. et Procès-Verbaux XXII, 1915) illustrate very plainly the high salinity in 1911 and the low salinity in 1912.

In 1907 which was an unfavourable year for the plaice fry in the Baltic proper (see page 25), the temperature was unusually low in January, February and March. The salinity of the inflowing bottom water was also below the nor-

mal in January and February; it did not rise above the mean at Gedser Rev until the beginning of March and remained low in the Sound also during that month.

In 1906 which was a favourable year (see page 25) the temperature was generally above the normal. The salinity on the other hand was most frequently below that of a normal year in January and February; only a short period in the end of January and the beginning of February exhibited high figures. In March the salinity generally was above the mean, but in April below.

In 1905 whic haccording to the investigations of Dr. Petersen, Prof. Reibisch and Dr. A. C. Johansen (see Rapp. et Procès-Verbaux XXII, 1915, pages 15—17) was an unfavourable year for the fry, the temperature was generally coincident with the normal, but the salinity of the bottom water was most frequently below the mean in the 3 first months of the year; especially the month of March had an unusually low salinity at Gedser Rev. In April on the other hand some very saline water came into our inshore waters.

In 1904 which both in the Baltic and the neighbouring waters was an especially bad fry-year, the temperature was a little below the mean, but above all the salinity was most frequently far below the normal in the first months of the year.

1903 was a little better; especially in February there came an inflow of saline water; but we know only very little about the quantity of fry in the Baltic in this year. Various catches in later years, however, seem to indicate that 1903 was a good fry-year (see A. C. Johansen l. c. 1915, page 17).

1902 which was a poor fry-year, exhibited low temperatures and extremely low salinities during the months January—April.

In 1901 no plaice fry was to be found at Bornholm (see page 8); there was ice during February and March, and pronounded low salinities during all the first 4 months of the year.

About the years 1896—1900 nothing is known with certainty concerning the amount of fry in the Baltic proper.

As to the years 1893 and 95, on the other hand, it has been mentioned above (page 31) that these years, which began with severe ice winters, were bad fry-years in contradistinction to 1894 in which year the temperature was relatiwely low, and the salinity, especially in the month of February, was likewise above the normal.

It will be seen from the above summary that the years during the first months of which high temperatures and high salinities prevailed in the bottom water, became favourable years for the appearance of young plaice in the Baltic proper, and vice versa. Also in the southern Kattegat and in the Belt Sea the quantity of fry seems, according to A. C. Johansen, mainly to be dependent on the same factors. It appears to be a general rule

that when there are poor fry-years in the last named places, there are at the same time still poorer fry-years in the Baltic proper; thus the renewal of the plaice stock in this water, so near the eastern limit for the occurrence of the plaice, is in a still higher degree dependent upon the hydrographical conditions in the first months of the year, than in the southern Kattegat and the Belt Sea.

V. The Future of the Plaice Fishery in the Baltic proper.

It goes without saying that the question about the renewal of the plaice stock is of the greatest interest for our plaice fishery in the Baltic proper; in the latter years this fishery has increased considerably. The yield of the Danish plaice fishery in this water was:

1917	31,485	kg
1918	32,615	»
1919	138,605	»
1920	179,407	»
1921	277,603	»
1922	322,319	»
1923	1,005,977	»
1924	2,009,011	»
1925	1,639,437	»

The large increase during the latter years is mainly due to the gradual increase of the number of cutters taking part in this fishery.

Such an intense fishery cannot but influence the composition and the density of the stock. As stated by Dr. Petersen (Rep. Biol. St. XXXI, 1925; see above page 14) it has brought about that the slow-growing old fish have now disappeared, giving place to a more quickly-growing, but less dense stock of younger fish. This so far is a profit, as the former stock was too dense, the plaice being, on account of want of good nourishment, „small, lean and of a very slight value" (Dr. Petersen in Rapports et Procès-Verbaux Vol. V, 1906, page 32—33). „The plaice South of Møen are the most miserable I ever have seen used for human food, and as a rule they could not be sold" the same author says in Rep. Biol. St. IV, 1894, page 26. But gradually as the old stock is fished away, we also in this water will be increasingly dependent upon the renewal which the stock receives through the annual appearance of fry, such as we have already been it during many years in the Kattegat and the Belt Sea.

When, therefore, it is a fact that the plaice fry in the Baltic proper can miss almost completely in some years, as for intance in 1904 and 1924, we must with more attention follow the thinning out of the stock in this water than in our other waters, where even the poorest fry-years yet give some fry. It is obvious

from the summary in the preceding chapter, that good fry-years in the latter years have occurred as frequently as poor ones. But if for instance the hydrographical conditions during a series of years should happen to be unfavourable for the appearance of the plaice fry, the risk may be run that the stock shortly after is diminished so much that it may mean a catastrophe for the plaice fishery in the Baltic proper.

Already now (1926) the fishermen begin to complain that the yield per fishing day is decreasing. Still, however, the large stock of older (15—20 years old) plaice is not quite fished up, although these „parrot-plaice" recently have become rare, even round Bornholm. For the present we have the plaice from the good fry-years 1921, 23 and 25 to fish upon, but in the future the appearance of the fry in the Baltic proper ought to be followed year by year, so that, if necessary, measures may be taken in time to protect the stock.

VI. Resumé.

1) During the summer of 1925 such a number of plaice of the 0-Group's bottom stage were found for the first time on the shores of the Baltic proper, as to compete numerically with the 0-Group in the neighbouring waters.

2) The investigations of the Danish Biological Station in 1925 showed that plaice of the year-class 1924 were almost entirely missing in the Baltic proper, whereas the year-class 1923 was numerously represented; the year-class 1922, again, only numbered relatively few specimens, but the year-class 1921 many.

3) During August 1925 many plaice of the 0-Group's bottom stage were caught in deep water in the Baltic proper; they were, on an average, larger than the 0-Group on the neighbouring shore; they therefore must, according to A. C. Johansen, be supposed to have emigrated from the shore.

4) Neither the immigration hypothesis of Dr. C. G. Joh. Petersen, nor the theory of Dr. A. C. Johansen that the main part of the fry is developped into deep water, can be maintained any longer. All the facts at hand tend to show that the renewal of the plaice stock in the Baltic proper takes place by the appearance of young plaice on the shores, these being, however, plentiful only in certain years; in other years the plaice fry may fail almost completely. It appears that the years 1893, 95, 1901, 02, 04, 05, 07, 12, 22 and 24 have been unfavourable years, the years 1894, 1903, 06, 11, 19, 21, 23 and 25 favourable years for the development of the plaice fry in the Baltic proper.

5) Among the factors of importance for the appearance of the fry, the temperature and the salinity in the water-layer near the bottom during the first months of the year must especially be emphasized; it has been shown that when the temperature and the salinity were relatively high in this period, the year as a rule has turned out to be a good fry-year for the plaice in the Baltic proper, and vice versa.

6) On occount of the intense fishery which now takes place in the Baltic, the stock is already considerably thinned out; it is, therefore, necessary in the future to examine annually the quantity of plaice fry growing up on the shores; the renewal of the stock will be of ever greater importance of the fishery the more the fishing-away of the older specimens advances.

I wish to conclude the present paper, the last of a long series of „Reports" edited by Dr. C. G. Joh. Petersen, with hearty thanks to this eminent investigator who now retires from his post as Director of the Danish Biological Station. I owe him thanks for his invaluable help and encouragement, not only during my work upon the present problem, but also during the 19 years in which I have had the good luck to be his assistant. I have learned so much through this long period of collaboration that I always will feel that I owe Dr. Petersen a very large debt of gratitude.

My thanks are also due to Capt. Speerschneider of the Dan. Meteorol. Institution, for his help with the working out of the hydrographical data, and to Mrs. Jehanne Russell, of London, for kind assistance in revising the English tranlation.

XII. I. Hvor og under hvilke Forhold kunne Rødspættens Æg udvikle sig til Unger indenfor Skagen? 1 Kort. II. Smaahvarrernes (*Zeugopterus*-Slægtens) Unger. 1 Tavle. III. Kunne vi optage Konkurrencen med Udlandets Damptrawlere i vore Farvande udenfor det danske Søterritorium? 1902 og 1903. 36 pg. (1903—04.)

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XV. I. First Report on the Oysters and Oyster Fisheries in the Lim Fjord. (70 pg.) 1908.

XVI. (Aalegræssets (*Zostera marina's*) Vækstforhold og Udbredelse i vore Farvande. 1908. 61 pg. (1906—07.)

XVI. On the Ecology and Distribution of the Grass Wrack (*Zostera marina*) in Danish Waters. With 9 figures.) 1908. 62 pg.

XVII. Studier over Østersfiskeriet og Østersen i Limfjorden. 1908. 24 pg. (1906—07.)

XVII. II. Second Report on the Oyster and Oyster Fisheries in the Lim Fjord. 1908. (24 pg.)

XVIII. I. Om Udbyttet af Limfjordens Fiskerier i de senere Aar samt om Rødspætteudplantningen i 1908. Med 6 Tabeller og 1 Kort. II. Biologiske Undersøgelser over Limfjordens Rødspættebestand. Med 3 Tabeller. III. Om Rejefiskeriets Udbytte fra 1885—1907 og dets Forbedring ved Fredning. Med 3 Tabeller. 25 pg. 1909.

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Selvstændige Publicationer.

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